AD-A077 004 RAYTHEON CO WALTHAM MASS RESEARCH DIV F/G 20/6
MANUFACTURING METHODS AND TECHNOLOGY PROGRAM ZINC SELENIDE BLAN--ETC(U)
MAY 79 R N DONADIO , J F CONNOLLY DAAB07-78-C-2038
UNCLASSIFIED S-2542 NL

1 OF 1
AD-
A077004

END
DATE
FILMED
12-79
DDC

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER DAAB07-78-C-2038	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) 6 Manufacturing Methods and Technology Program Zinc Selenide Blanks for Windows and Lens Elements.		5. TYPE OF REPORT & PERIOD COVERED 9 ~~Third~~ Quarterly Progress rept. no. 3 1 Feb [redacted]-30 Apr[redacted]79
		6. PERFORMING ORG. REPORT NUMBER 14 S-2542
7. AUTHOR(s) 10 R. N./Donadio J. F./Connolly		8. CONTRACT OR GRANT NUMBER(s) 15 DAAB07-78-C-2038
9. PERFORMING ORGANIZATION NAME AND ADDRESS Raytheon Research Division 28 Seyon St. Waltham, MA 02154		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Project No. 2789841
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Electronic R&D Command Night Vision and Electro-Optics Laboratory DELNV-SI, Fort Belvoir, VA 22060		12. REPORT DATE 11 May [redacted]79
		13. NUMBER OF PAGES 13
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office) 12 24		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Infrared Materials
Low-Cost Zinc Selenide
Chemical Vapor Deposition
High Volume Manufacture

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The confirmatory sample deposit was successfully completed during this reporting period. Initial testing and evaluation show optical and mechanical properties will meet program requirements.

298 320 Gm

DD FORM 1 JAN 73 1473

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

MANUFACTURING METHODS & TECHNOLOGY PROGRAM

ZINC SELENIDE BLANKS FOR WINDOWS AND LENS ELEMENTS

Third Quarterly Progress Report

1 February 1979 to 30 April 1979

Object of Study

The objective of this manufacturing methods and technology program is to establish the capability to manufacture high volume zinc selenide blanks for infrared windows and lens elements.

Contract No. DAAB07-78-C-2038

Distribution Statement

Approved for public release; distribution unlimited

ABSTRACT

The confirmatory sample deposit was successfully completed during this reporting period. Initial testing and evaluation show optical and mechanical properties will meet program requirements.

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

GLOSSARY

Absorption Coefficient - Fraction of energy lost while traversing a pathlength of one centimeter through a material.

Chemical Vapor Deposition - A process by which chemicals are reacted in the vapor phase to form a compound.

Deposition Temperature - Temperature of the reaction zone in which the chemical vapor deposition takes place.

Evaporator - Apparatus used to form a vapor (or gas) from a solid (or liquid).

Flexural Strength - Maximum fiber stress a material will withstand before rupture in bending.

Image Spoiling Characteristics - That property of a transparent material that defines the ability to resolve discrete images.

Retort - High temperature container used to hold liquid zinc.

Substrate - A form on which material is deposited, sometimes called a mandrel.

Zinc Reservoir System - Apparatus containing one or several liquid zinc retorts and associated monitoring and controlling devices.

1.0 PURPOSE

The purpose of this manufacturing and methods technology program is to establish an automated production process for the fabrication of high optical quality zinc selenide.

The program is of seventeen months duration and is sponsored by the United States Army Electronics Research and Development Command. It addresses itself to the further automation of an existing production process for the chemical vapor deposition of zinc selenide. Raytheon Company has successfully developed the techniques and facilities to fabricate state-of-the-art CVD zinc selenide in large sizes. It is anticipated that with improvements in automated processing the price for standard size lens blanks will be reduced to 50 percent of the catalog price. In addition, the use of a curved substrate may further reduce the price of the color correcting lens blank shown in Figure 1 to less than $200 each for large volume purchases.

The program has been divided into three phases. In the first phase, zinc selenide test blanks will be produced using the existing process. In Phase II of the program the zinc reservoir system will be replaced with an automated external zinc supply, and blanks will be deposited for confirmation of the optical and mechanical characteristics of the material. The third phase of the program will demonstrate the production capability of a pilot line to manufacture high-quality zinc selenide blanks at four-hundred and eighty-one (481) units per month.

PBN-79-126

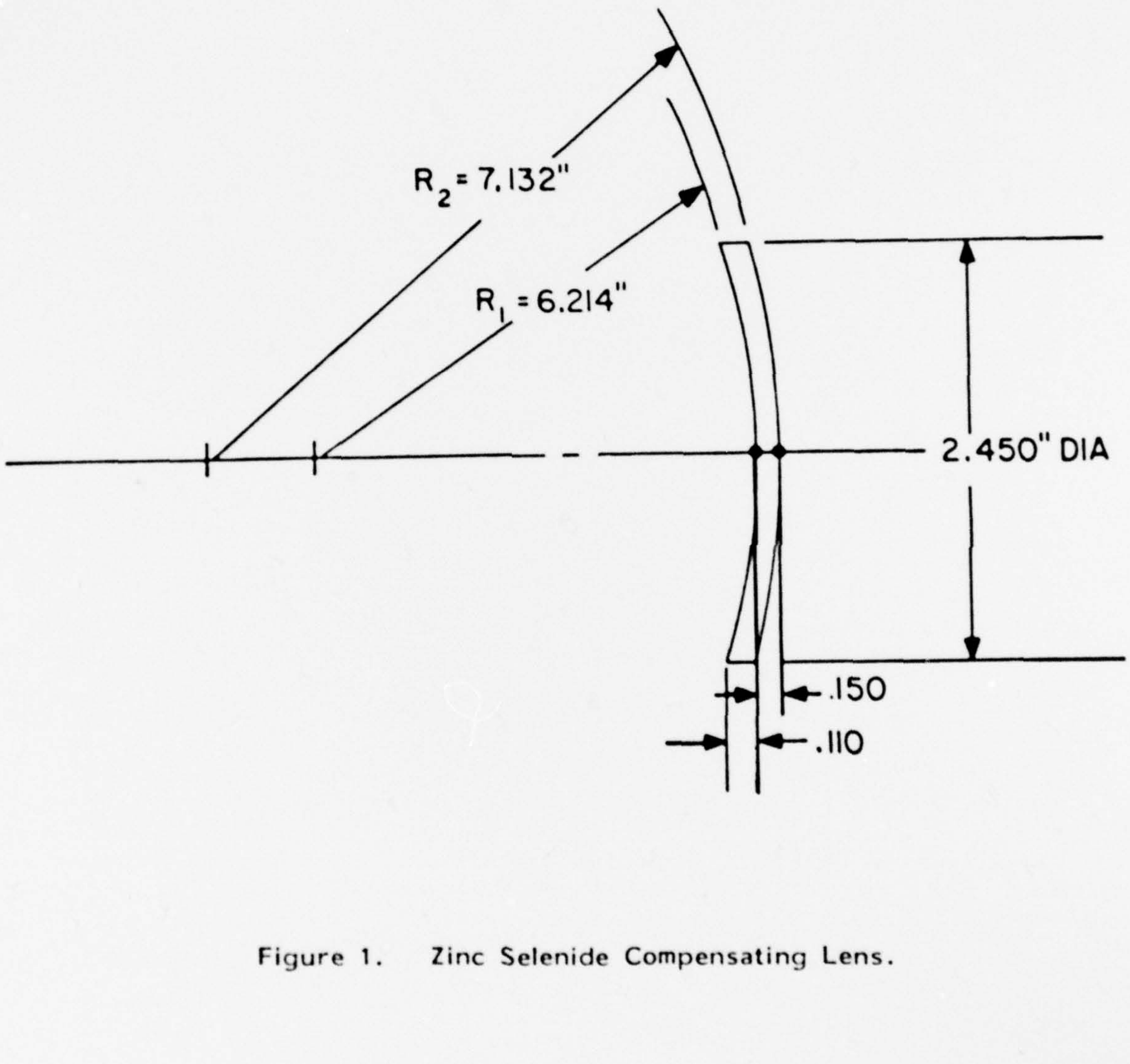

Figure 1. Zinc Selenide Compensating Lens.

2.0 NARRATIVE AND DATA

2.1 Confirmatory Sample Deposit

2.1.1 Deposition

A 143 hour zinc selenide deposit was conducted to yield the required confirmatory samples. (Table 1 presents the deposition conditions for this deposit.) The deposit was made in a graphite box mandrel of inside dimensions 12 X 22 X 63 inches. The curved mandrel concept was incorporated in the graphite substrate producing zinc selenide lenses to near finished dimensions on one side. Figure 2 displays the curved mandrel concept as described in a previous report.

The thickness profile for one of the deposited plates is presented in Figure 3 revealing adequate overall thickness and uniformity. Also shown is the location of the concave lens sites and the thickness of the lens blanks. Two witness samples were fabricated from the deposit for preliminary optical evaluation. The infrared and visible transmittance curves for these samples are shown in Figures 4 through 7 revealing transmittance values that meet the program requirements. The two samples were measured for absorption coefficient at 10.6 μm, yielding a β (including surface absorption) = 0.0019 cm^{-1}.

Flexural test specimens approximately 1/4 X 1/4 X 2-1/4 inch were prepared from the top and bottom of the deposit. Table 2 contains the data for this modulus of rupture test. All samples meet the minimum strength requirement of 6570 psi.

The zinc vaporization system performed well throughout the 143 hour deposit. No malfunctions of any kind were detected.

TABLE 1

DEPOSITION CONDITIONS

Run No.	Temp (°C)	Furnace Pressure (torr)	H_2Se Usage (lpm)	Zinc Usage (g/hr)	Deposition Time (hrs)
Pre-engineering	730	24	4.0	700	84
Engineering Deposit	730	24	4.2	735	327
Confirmatory Deposit	750	25	5.0	874	143

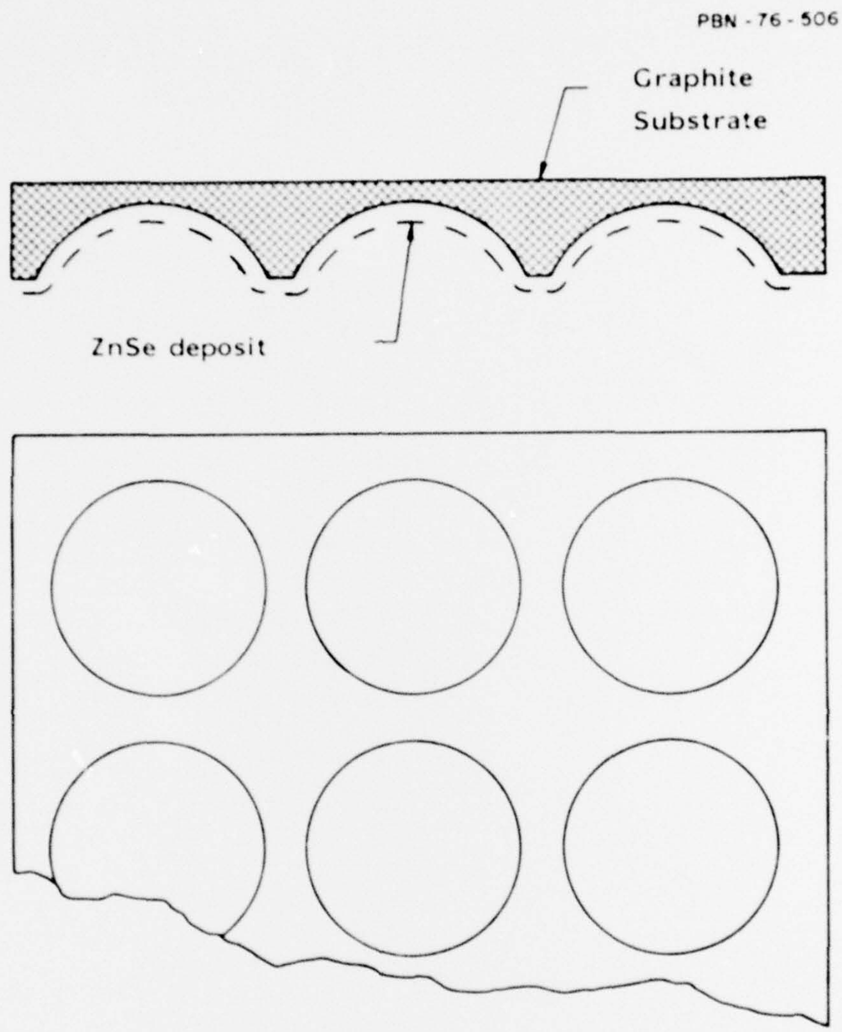

Figure 2. Curved Mandrel.

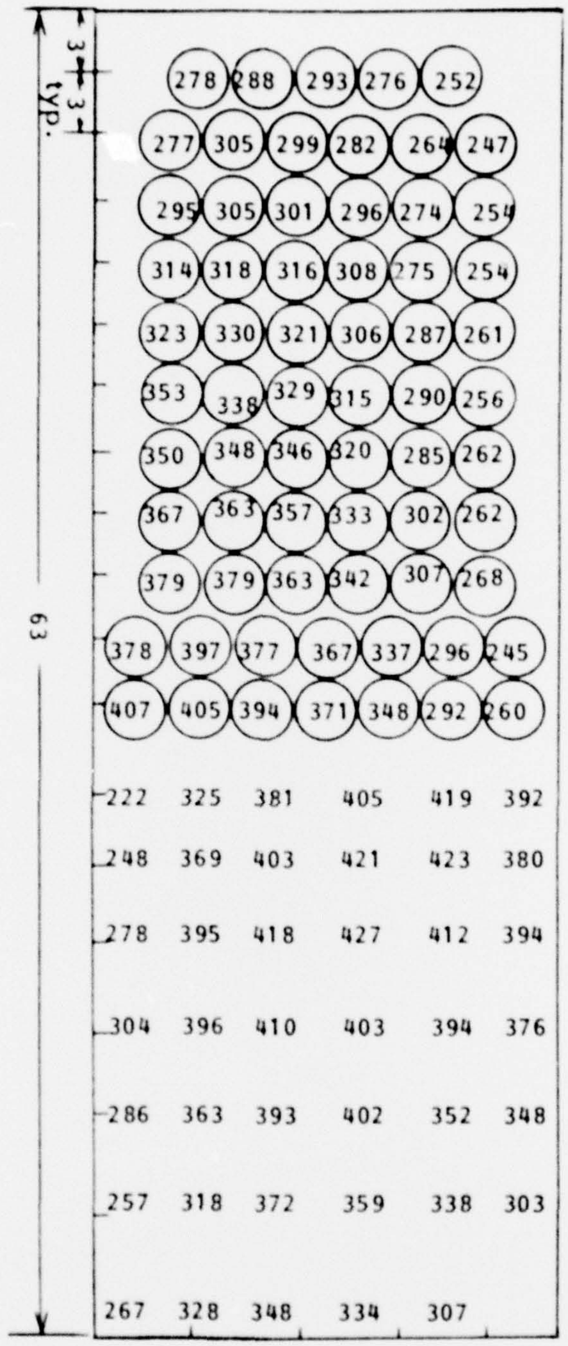

Figure 3. Thickness Profile, Plate A, Confirmatory Deposit.

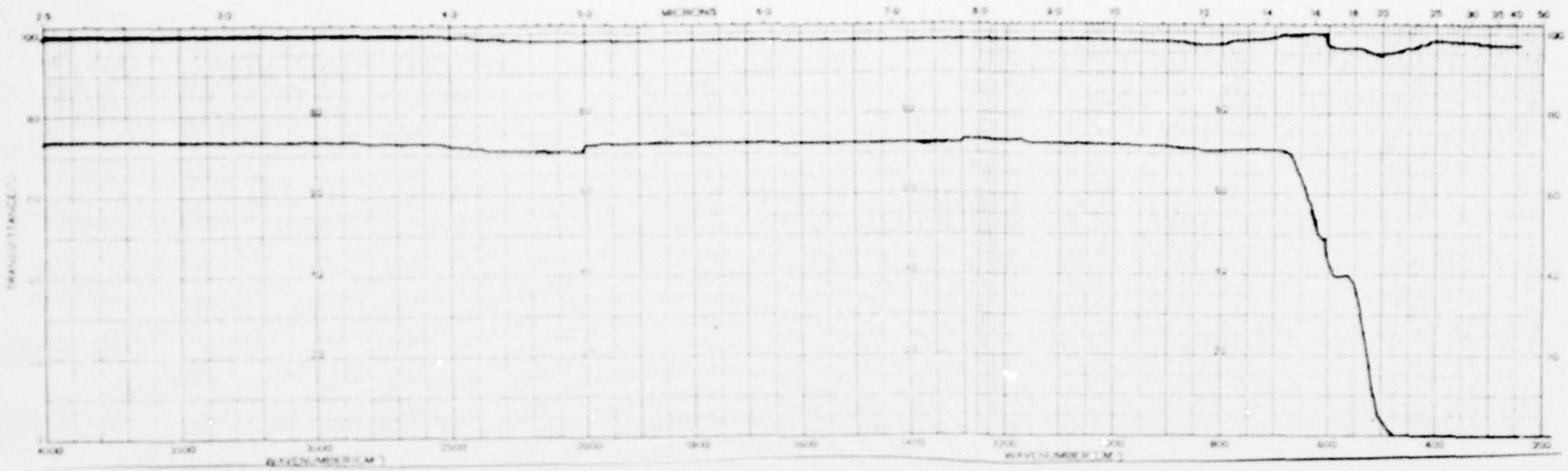

Figure 4. Infrared Transmittance, Confirmatory Deposit, Sample No. 1, t = 0.373 in.

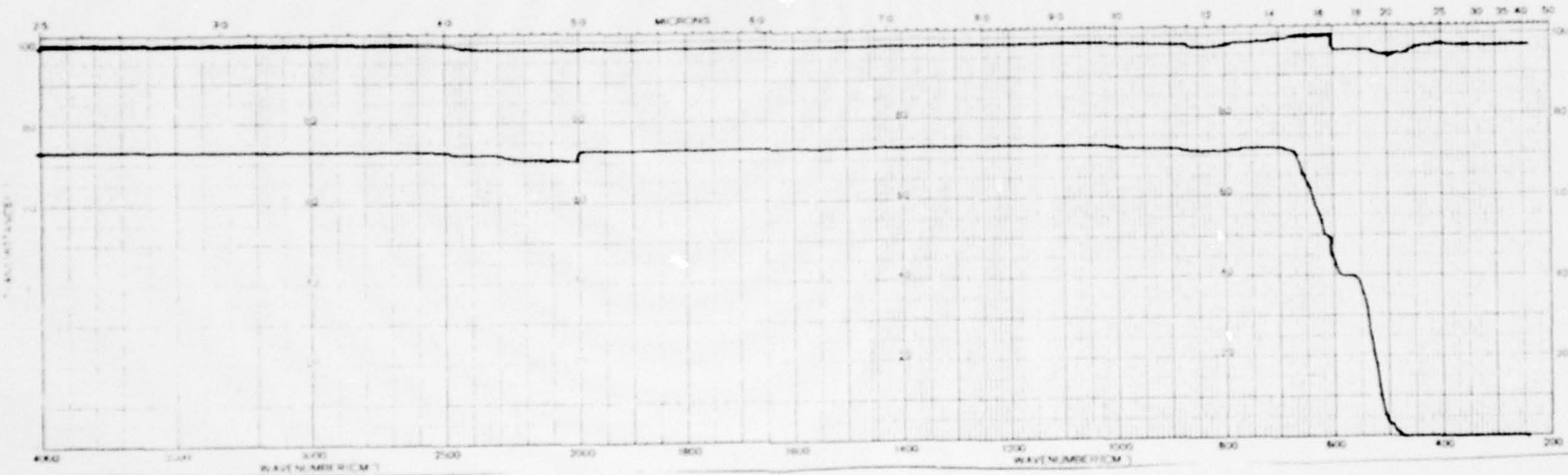

Figure 5. Infrared Transmittance, Confirmatory Deposit, Sample No. 2, t = 0.374 in.

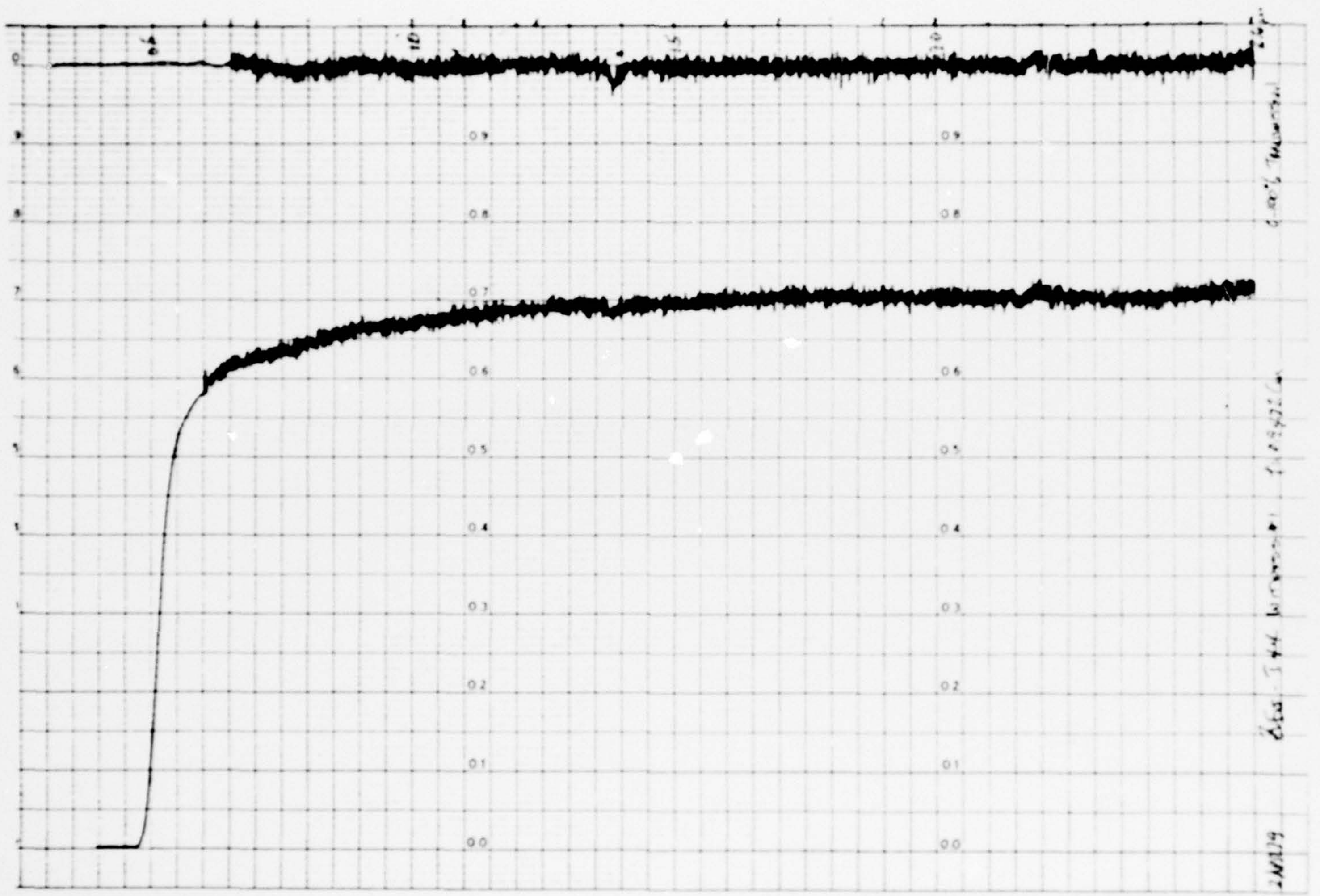

Figure 6. Visible Transmittance, Confirmatory Deposit, Sample No. 1, t = 0.373 in.

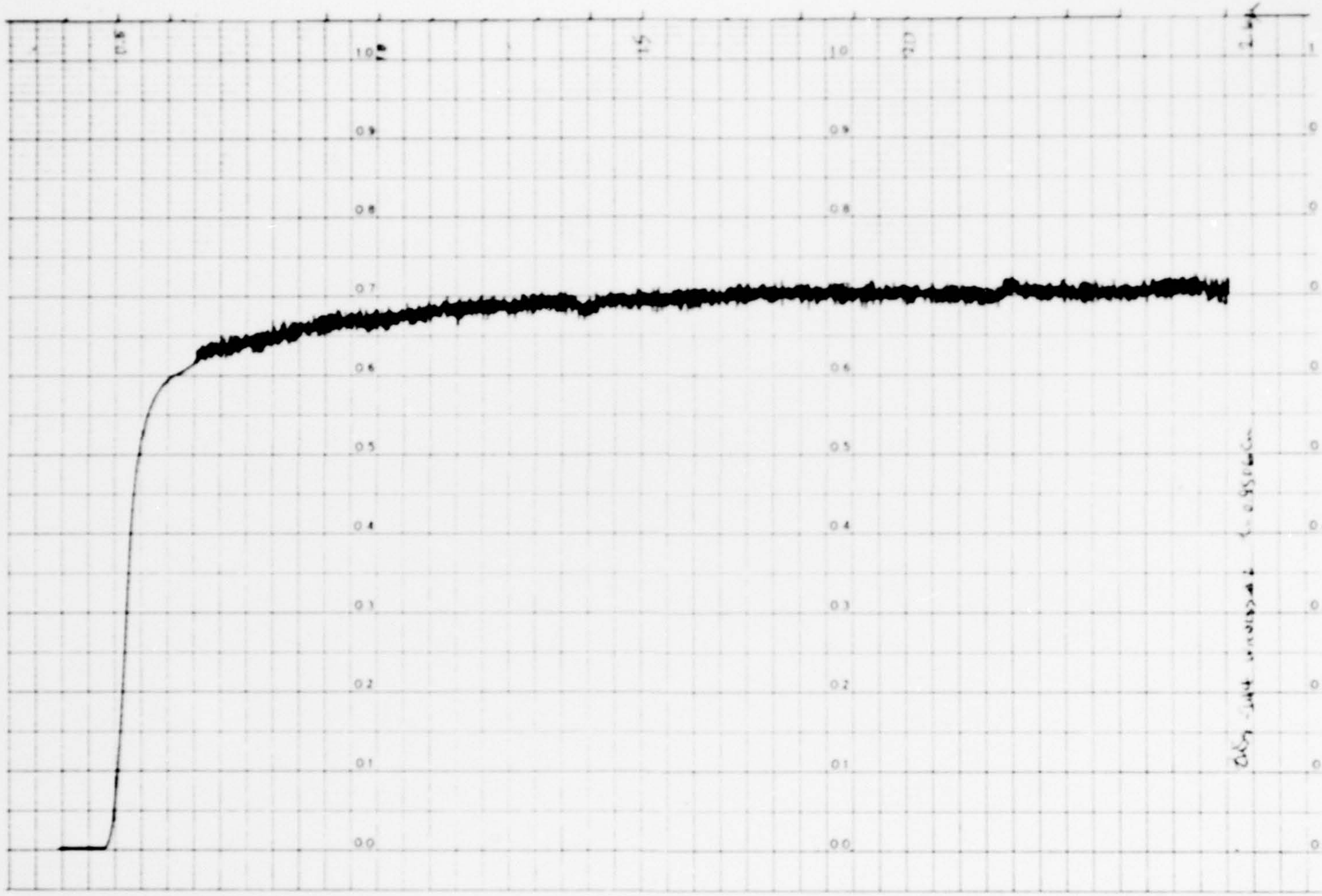

Figure 7. Visible Transmittance, Confirmatory Deposit, Sample No. 2, t = 0.374 in.

TABLE 2

MODULUS OF RUPTURE DATA FOR CONFIRMATORY DEPOSIT

4-Point Loading

TOP

Sample No.	Strength (psi X 10^3)
1	9.57
2	9.60
3	9.27
4	8.11
5	6.61

BOTTOM

Sample No.	Strength (psi X 10^3)
1	8.49
2	6.91
3	6.71
4	7.18
5	8.87

Avg. 8.13 ± 1.2

2.1.2 Sample Requirements

The zinc selenide from the confirmatory deposit shall be fabricated into: (20) lens blanks having sufficient material to yield the lens element as per drawing No. SM-C-804146, (2) 49 mm diameter X 6.35 mm thick, (2) 61 mm diameter X 6.35 mm thick, and (2) 67.5 mm diameter X 6.35 mm thick. These blanks or witness samples will be tested to meet the following specifications:

a) Transmission

The uncoated transmittance for a 6.35 mm thickness shall be greater than 58 percent over the wavelength region 8 to 13 um at normal incidence. Over the wavelength region 0.6 to 1.1 μm the transmittance shall be greater than 43 percent.

b) Inclusions

The maximum size inclusion is 0.625 mm. The permissible number of maximum size inclusions is one per each cubic centimeter of material. The sum of the diameters of all inclusions in any given cubic centimeter of material shall not exceed 0.625 mm. Bubbles are classified as inclusions.

c) Surface Hardness

The Knoop, 50 gram, hardness rating shall be at least 100.

d) Absorption

The absorption over the 8 to 12 μm region will be less than 0.01 per centimeter. The absorption at 10.6 μm will be less than 0.005 per centimeter.

e) Scatter

The angular spread of a focused spot on a blank 6.35 mm thick shall increase by more than 15 percent over the angular spread of the same spot without the sample in the beam over the wavelength region 0.6 to 1.2 μm. The angular spread over the wavelength region 8 to 12 μm will be less than 2 percent.

f) Rupture Modulus

The modulus of rupture shall be an average 7300 pounds per square inch and a minimum value not less than 6570 psi.

g) Parallelism

The provided blanks shall have maximum allowable wedge of 10 minutes. The blank(s) used for image spoiling tests will have a maximum wedge of 0.5 minute.

h) Strain

The distribution of permanent strain shall be symmetrical, and the birefringence resulting from permanent strain will not produce more than 10 nanometers relative retardation or path difference per centimeter of a transmitted narrow-band light source.

i) Chips and Fractures

A vented fracture exceeding 10 mm in length or aiming at the center of the blank shall be rejected. Blanks having pressure or fire cracks deeper than 1 mm shall be rejected. Other surface irregularities, pits, or cracks shall not extend into 2.55 mm diameter of the blanks required to yield the lens, as per drawing No. SM-C-804146.

3.0 CONCLUSIONS

The confirmatory sample deposit was successfully completed yielding sufficient material to produce the required number of lens blanks. Initial testing for the optical quality of the zinc selenide shows good transmittance and low absorption coefficient. It is anticipated there will be no difficulty in meeting the program requirements for all properties of interest.

4.0 PROGRAM FOR NEXT INTERVAL

Testing and evaluation of the confirmatory deposit samples will be conducted. Preparations for the pilot product run will begin.

5.0 PUBLICATIONS

There were no publications during this reporting period.

6.0 PERSONNEL

The following are the worked manhours for key personnel on this program:

Name	Manhours During Report Period
Mr. R. Donadio	70.0
Mr. J. Connolly	324.0
Dr. T. Kohane	99.0
Mr. T. Varitimos	192.0
Research Technicians	442.5
Publications Specialists	17.5
Total	1,145.0

DISTRIBUTION LIST

Commander
Defense Documentation Center
ATTN: DDC-TCA (Quantity 12)
Cameron Station, Building 5
Alexandria, VA 22314

HQDA (DAMA-WSA)
ATTN: LTC Waddel
Washington, DC 20310

HQDA
ATTN: DAMA-CSC-ST
Room 3D43
Pentagon
Washington, DC 20310

Commander
Air Research & Development Command
ATTN: RDTCT
Andrews AFB
Washington, DC

Development and Readiness Command
ATTN: DRCMT (Mr. Fred Michel)
5001 Eisenhower Avenue
Alexandria, VA 22333

Commander
US Army Materiel Development & Readiness Command
ATTN: DRCQA
5001 Eisenhower Avenue
Alexandria, VA 22333

Commandant
US Army Aviation School
ATTN: ATZQ-D-MA (O. Heath)
Fort Rucker, AL 36360

Director
US Army Production Equipment Agency
ATTN: Mr. C. McBurney
Rock Island Arsenal
Rock Island, IL 61299

Commander
US Army Missile Command
ATTN: DRSMI-RR (Dr. J. P. Hallowes)
Redstone Arsenal, AL 35809

Commander
US Army Tank-Automative Command
ATTN: DRSTA-RW-L
Warren, MI 48090

Commander
US Army Missile Command
ATTN: DRSMI-RE (Mr. Pittman)
Redstone Arsenal, AL 35809

Commander
US Army Tank-Automative Command
ATTN: DRSTA-RHP (Dr. J. Parks)
Warren, MI 48090

Commander
US Army Missile Command
Redstone Scientific Info. Center
ATTN: Chief, Document Section
Redstone Arsenal, AL 35809

US Army Missile Command
ATTN: DRSMI-RGP (Mr. Victor Ruwe)
Redstone Arsenal, AL 35809

Commander
US Army Materials and Mechanics Research Center
ATTN: DRXMR-M (N.H. Fahey)
Watertown, MA 02172

Director
US Army Industrial Base Engineering Activity
ATTN: DRXIB-MT
Rock Island, IL 61299

Commander
Picatinny Arsenal
ATTN: SARPA-TS-S No. 59
Dover, NJ 07801

DISTRIBUTION LIST

Commander
US Naval Air Systems Command
ATTN: AIR 335 (Mr. E. Cosgrove)
Washington, DC 20361

Commander
Department of the Navy, ELEX 05143A
ATTN: A. H. Young
Electronics System Command
Washington, DC 20360

Chief
Naval Ship Systems Command
Department of the Navy
ATTN: Code 681A2b (Mr. L. Gumina)
Room 3329
Washington, DC

Commander
US Navy Weapons Center
Michelson Lab
ATTN: Code 6018 (H. E. Barnett)
China Lake, CA 93555

Director
Naval Research Laboratory
ATTN: Code 2627
Washington, DC 20375

Commander
US Naval Air Development Center
ATTN: CODE 202 (Mr. T. J. Shopple)
Johnsville, Warminister, PA 18974

Commander
Naval Ocean Systems Center
Code 9254 (ATTN: Mr. Richard Gamble)
San Diego, CA 92152

Commander
US Air Force Materials Laboratory
ATTN: AFML/CPO (Mr. D. Fisher)
Wright Patterson AFB
Dayton, OH 45433

NASA Scientific & Tech
Information Facility
P.O. Box 8757
Baltimore/Washington, Int'l Airport

Bell & Howell Corporation
ATTN: Mr. George R. McGee
7100 McCormick Road
Chicago, IL 60645

Director
Optical Sciences Center
University of Arizona
Tucson, AZ 85721

Dr. Arthur Cox
1116 South Aldine Avenue
Park Ridge, IL 60068

Farrand Optical Co. Inc.
ATTN: Mr. Martin Shenker
117 Wall Street
Valhalla, NY 10595

Grumman Aerospace Corp.
Research Dept. and Advanced
Development Dept.
Bethpage, NY 11714

Hughes Aircraft Corporation
ATTN: Mr. Phil Henning
P.O. Box 90515
Los Angeles, CA 90009

Martin Marietta Corporation
ATTN: Mr. James Ohmart (MP276)
P.O. Box 5837
Orlando, FL 32805

Melles Griot
1770 Kettering Street
Irvine, CA 92714

DISTRIBUTION LIST

Northrop Corporation
Electro-Mechanical Division
ATTN: Mr. Paul Holderman
500 East Orangethorpe Avenue
Anaheim, CA 92801

Optic-Electronic Corporation
ATTN: Mr. Bryan Coon
11477 Page Mill Road
Dallas, TX 75243

Optical Coating Laboratory, Inc.
2789 Giffen Avenue
P.O. Box 1599
Santa Rosa, CA 95402

Optical Systems & Technology Inc.
ATTN: Mr. Harry W. A. Vandermeer
4 Alfred Circle
Bedford, MA 01730

Rockwell International
Corporation Science Center
Thousand Oaks, CA

Space Optics Research Labs
ATTN: Mr. C. A. Pipan
7 Stuart Road
Chelmsford, MA 01824

Tinsley Laboratories Inc.
2448 Sixth Street
Berkeley, CA 94710

Director
US Army Night Vision & Electro-Optics
Laboratory (Quantity 5)
ATTN: DELNV-SI (R. Spande)
Fort Belvoir, VA 22060